Hi-Tech for Archeology

Application of remote sensing to archeological reconnaissance exemplifies technology transfers in the related fields of resources management and environmental control

On the shores of Lake Arenal in northeastern Costa Rica, University of Colorado scientists are uncovering a wealth of information about an Indian culture that began there about 2000 B.C. and flourished for some 3,500 years before the Spanish conquest of the 16th century. The discoveries represent an archeological triumph, but they are the more exciting because they constitute an impressive demonstration of the tremendous potential of remote sensing technology in archeological reconnaissance.

Blanketed by thick tropical vegetation and covered by several feet of volcanic ash from 10 major eruptions of Arenal Volcano, the area is difficult to explore on foot. But remote sensing offers a means of accelerating the ground-based effort by steering field investigators to the potentially most productive areas. Looking at Earth in wavelengths of the electromagnetic spectrum invisible to the human eye, electronic remote sensing equipment in satellites and aircraft provides images that reveal hidden detail of immense archeological importance.

NASA's Thomas L. Sever, who conducted the Arenal remote sensing operations, has an analogy to explain the great difference between what can be seen by the naked human eye and by advanced remote sensing equipment. "If," he says, "the electromagnetic spectrum were a line 25,000 miles long—roughly the circumference of the Earth—the unaided eye could see only a piece of that line as wide as a pencil."

Sever is an archeologist and a remote sensing specialist with the Earth Resources Laboratory of NASA's National Space Technology Laboratories (NSTL); his job is to assist scientific groups, not only in archeology but in such other areas as land resources inventory and land development. Remote sensing is the process of acquiring physical information from a distance, for example, obtaining data on Earth features from a satellite or an airplane. Aerial photography is a form of remote sensing, but it is usually limited to the extremely narrow visible light portion of the spectrum. Advanced remote sensing instruments detect radiations—not visible to the ordinary camera or the human eye—in several bands of the spectrum; these data are computer processed to produce "multispectral" images that can provide enormous amounts of information about Earth objects or phenomena. Since every object on Earth emits or reflects radiation in its own unique "signature," remote sensing data can be interpreted to tell the difference, for example, between one type of vegetation and another, between densely populated urban areas and lightly populated farmland, between clear and polluted water or—in the archeological application—between rain forest and hidden man-made structures.

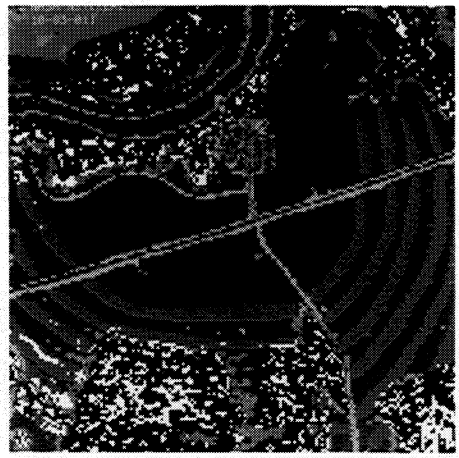
More than a decade ago, local inhabitants of the Lake Arenal area began finding ancient artifacts and that led to the University of Colorado's research project, financially supported by the National Geographic Society and the National Science Foundation. However, it was not until remote sensing was employed that the researchers began to comprehend the scope of the Arenal find.

Beginning in 1984 and continuing into 1986, Tom Sever applied satellite data together with infrared imagery he acquired on several flights over the area in a NASA remote sensing aircraft. This input enabled the University of Colorado's Payson D. Sheets, project director, to plan field investigations that led to excavation of 62 sites, such as villages, cemeteries, buildings and tombs. The most impressive contribution of remote sensing was discovery of many footpaths

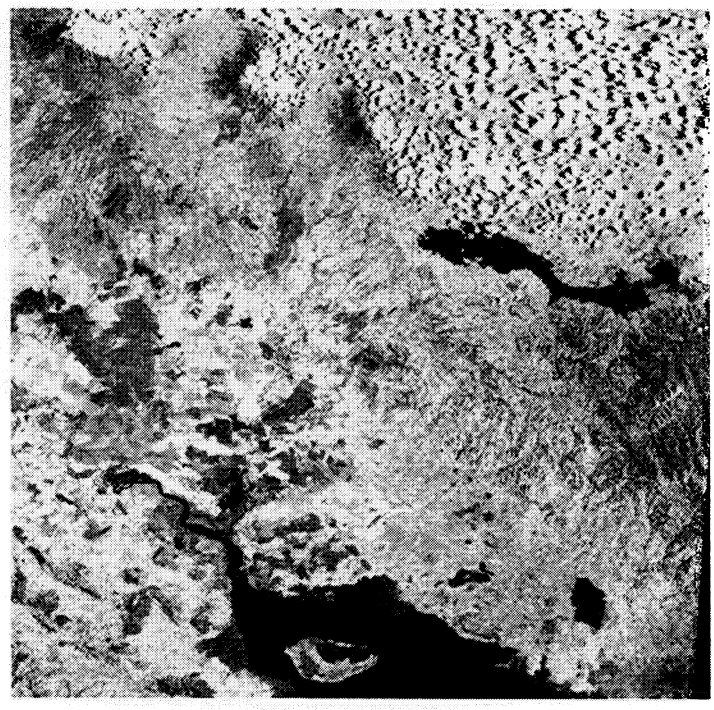
buried under the volcanic ash; tracing the footpaths, which seemed to connect villages with cemeteries, springs and stone quarries, provided a great deal of information about movement patterns and lifestyle of the ancient Indians, and also suggested sites for excavation. Director Sheets became an enthusiast of remote sensing in archeology. "It really is a new window on the past," he says.

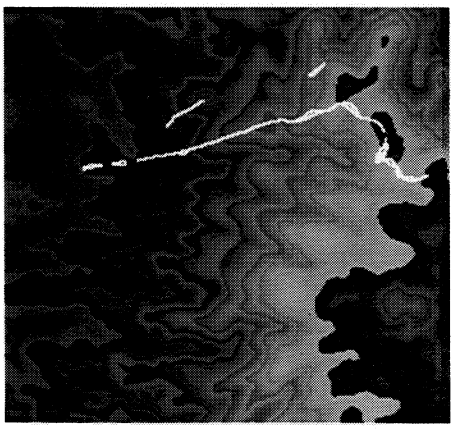
Seeking to acquaint the archeological community with the potential of remote sensing, NASA has for several years been conducting demonstrations. For example, at Poverty Point, Louisiana, processing of remotely sensed data provided detailed imagery of a prehistoric site that may represent the oldest civilization in the United States. In New Mexico's Chaco Canyon, satellite images showed prehistoric roads invisible to the naked eye, built by the Anasazi culture about 900 A.D. In Kenya, remote sensing assisted noted researcher Richard Leakey in his search for early hominid remains, and in the desert of Sudan, remote sensing instruments penetrated deep into the Earth to find subterranean evidence of a culture that existed some 200,000 years ago.

Archeologists have been slow to accept remote sensing techniques, but recent successes have made a strong impression. Use of the technology is beginning to expand and some universities have already established Centers for Remote Sensing. Tom Sever stresses that remote sensing is not intended to locate individual arrowheads or pottery shards, nor to replace the archeologist's skills and the need for painstaking excavation; rather it offers a time-saving, low-cost way of prioritizing the archeologist's work and pinpointing sites for excavation. Remote sensing technology is itself advancing rapidly and, says Sever with respect to the archeological application, "What we will be able to do within a few years is literally unbelievable." ▲



At left is a remotely sensed image of an archeological site at Poverty Point, Louisiana that may represent the oldest civilization in North America. The image, which shows a large central plaza surrounded by six concentric ridges, contains many features of importance to archeologists.





In the center photo is a topographic image of Costa Rica's Lake Arenal area prepared from data acquired by a Landsat satellite. Enhancement of satellite data, coupled with infrared imagery from a remote sensing aircraft, led to discovery of the otherwise invisible footpaths (white lines) shown at left. Tracing and excavating the footpaths provided a wealth of information about an Indian culture that existed in the area some 4,000 years ago.